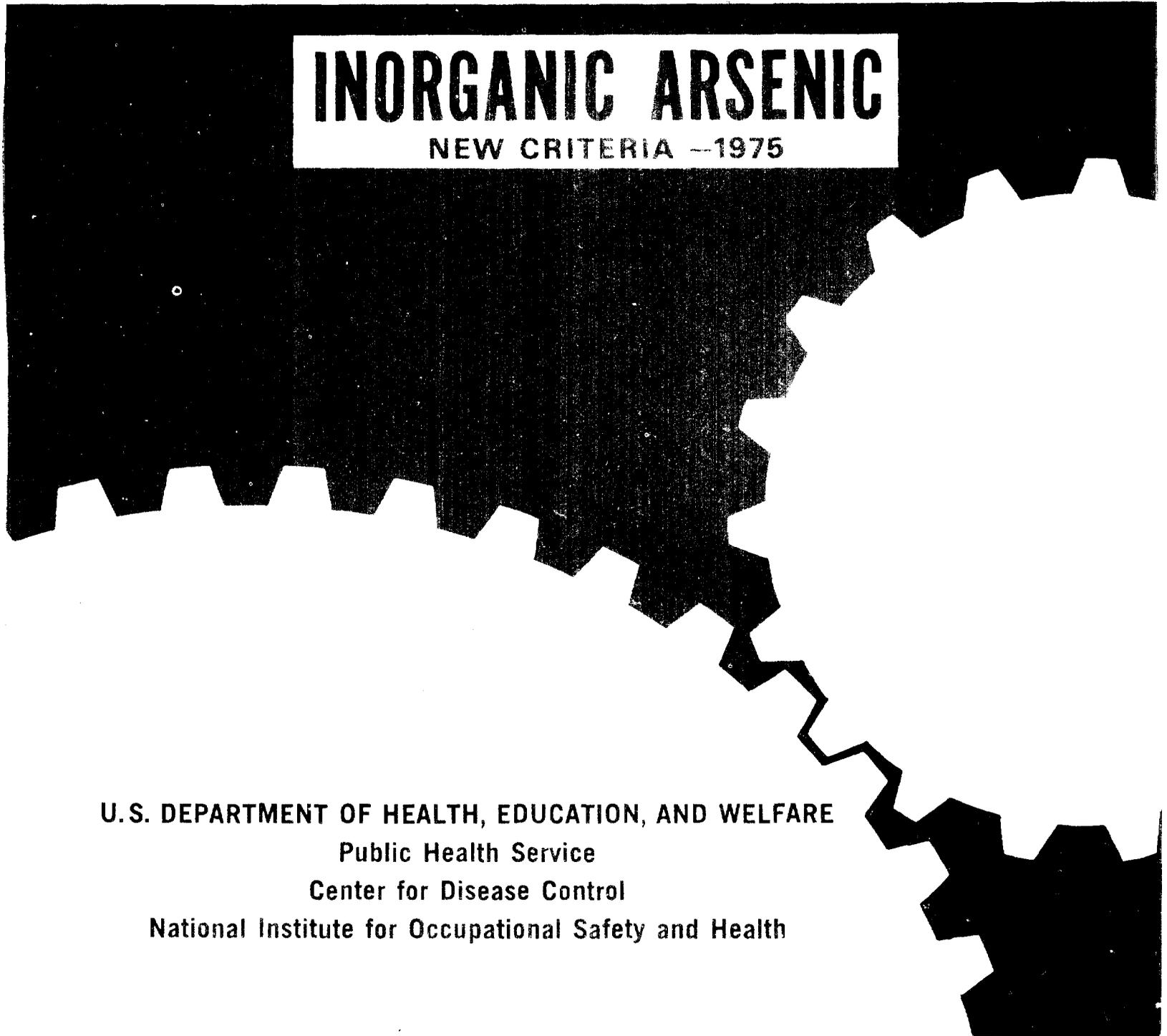


criteria for a recommended standard

OCCUPATIONAL EXPOSURE TO

INORGANIC ARSENIC

NEW CRITERIA —1975



U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Center for Disease Control
National Institute for Occupational Safety and Health

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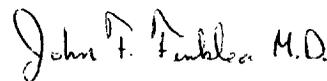
PREFACE TO THE REVISED RECOMMENDED STANDARD

When the document on Occupational Exposure to Inorganic Arsenic was originally developed, it was apparent that inorganic arsenic had been a factor in the development of occupationally related lung cancer, but the evidence was not unequivocal. Although data were not available which could validate any specific concentration as an occupational health limit, NIOSH acted because of the seriousness of the disease. Even in the absence of data demonstrating the absolute safety of the recommended environmental limit, a workroom limit was recommended which it was believed would "at the minimum, significantly reduce the incidence of arsenic-induced cancer."

Beginning in July, 1974, unpublished reports on occupational exposure to inorganic arsenic were made available to NIOSH by Allied Chemical Corporation, The Dow Chemical Corporation, and Kennecott Copper Corporation. After reviewing these papers and several additional reports that were subsequently published, NIOSH on November 8, 1974, transmitted to the Department of Labor modified recommendations for an inorganic arsenic standard. As new information continued to accumulate, NIOSH further modified its recommendations at the public hearing held by the Occupational Safety and Health Administration on April 8, 1975. This new Criteria Document contains the modified recommendations for an inorganic arsenic standard and incorporates discussions of the additional information that has been considered. The revised criteria and recommended standard were prepared in the Office of Research and Standards Development with the valuable assistance of Elliot S. Harris, Ph.D., Director, Division of Laboratories and Criteria Development; J. William Lloyd, Sc.D., Director, Office of Occupational Health Surveillance and Biometrics; William L.

Wagner, Industrial Hygiene Engineer, Western Area Occupational Health Laboratory; and of Joseph K. Wagoner, S.D. Hyg., Director, Division of Field Studies and Clinical Investigations.

When the inorganic arsenic criteria document was first published, arsine and lead arsenate were excluded from the provisions of the recommended standard. They are included in these revised recommendations, although the inclusion of arsine poses some difficulties in that specific work practices for arsine are needed, and sampling methods for arsine and other arsenical gases need to be refined. NIOSH is working on these areas and will transmit recommendations directly to the Occupational Safety and Health Administration, but these difficulties should not be cited as cause for permitting continued worker exposure to arsine at concentrations above 0.002 mg (2.0 (u)g) As/cu m. NIOSH also recognizes that the stringent occupational exposure limit recommended, based on our evaluation of the health hazards, presents a difficult regulatory problem for agencies such as the Environmental Protection Agency and the Occupational Safety and Health Administration. However, it is not possible at present to determine a safe exposure level for carcinogens. In the interest of worker safety and health, NIOSH has recommended restricting exposure to very low levels that can be reliably measured.



John F. Finklea, M.D.
Director, National Institute for
Occupational Safety and Health

OFFICE OF RESEARCH AND STANDARDS DEVELOPMENT
REVIEW COMMITTEE FOR THE
REVISED RECOMMENDED INORGANIC ARSENIC STANDARD

Herbert E. Christensen, D.Sc.
Deputy Director

Bryan D. Hardin
Criteria Manager, Criteria Development Branch

Keith H. Jacobson, Ph.D.
Senior Scientist

Jon R. May, Ph.D.
Chief, Criteria Development Branch

Howard L. McMartin, M.D.
Acting Director

Frank A. Mitchell, D.O.
Special Assistant for Medical Affairs

PREFACE

The Occupational Safety and Health Act of 1970 emphasizes the need for standards to protect the health and safety of workers exposed to an ever-increasing number of potential hazards at their workplace. To provide relevant data from which valid criteria and effective standards can be deduced, the National Institute for Occupational Safety and Health has projected a formal system of research, with priorities determined on the basis of specified indices.

It is intended to present successive reports as research and epidemiologic studies are completed and sampling and analytic methods are developed. Criteria and standards will be reviewed periodically to ensure continuing protection of the worker.

I am pleased to acknowledge the contributions to this report on inorganic arsenic by members of my staff, by the Review Consultants on Inorganic Arsenic, by the ad hoc committees of the American Industrial Hygiene Association and of the Society of Toxicology, by Robert B. O'Connor, M.D., NIOSH consultant in occupational medicine, and by Edwin C. Hyatt on respiratory protection. The NIOSH recommendations for standards are not necessarily a consensus of all the consultants and professional societies that reviewed this criteria document on inorganic arsenic. Lists of the NIOSH Review Committee members and of the Review Consultants appear on the following pages.



Marcus M. Key, M.D.
Director, National Institute for
Occupational Safety and Health

The Office of Research and Standards Development, National Institute for Occupational Safety and Health, had primary responsibility for development of the criteria and recommended standard for inorganic arsenic. Tabershaw-Cooper Associates, Inc. developed the basic information for consideration by NIOSH staff and consultants under contract No HSM-99-72-127. Bryan D. Hardin had NIOSH program responsibility and served as criteria manager.

REVIEW COMMITTEE
NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

John M. Bryant
Acting Deputy Director, Division of
Laboratories and Criteria Development

George J. Butler
Division of Technical Services

A. Walter Hoover, M.D.
Director, Division of Occupational
Health Programs

Frank L. Mitchell, D.O.
Office of Research and
Standards Development

Robert L. Peterson
Chief, Western Area Occupational
Health Laboratory

Herbert E. Stokinger, Ph.D.
Division of Laboratories and
Criteria Development

Joseph K. Wagoner, S.D. Hyg.
Director, Division of Field Studies and
Clinical Investigations

Ex Officio:

Charles H. Powell, Sc.D.
Assistant Institute Director for
Research and Standards Development

NIOSH REVIEW CONSULTANTS ON INORGANIC ARSENIC

B. D. Dinman, M.D., Sc.D.
Director, Institute of Environmental and
Industrial Health
University of Michigan
School of Public Health
Ann Arbor, Michigan 48104

Kenneth W. Nelson
Director, Department of
Environmental Sciences
American Smelting and Refining Company
3422 South - 700 West
Salt Lake City, Utah 84119

William W. Payne, Sc.D.
Deputy Director, National Institute of
Environmental Health Sciences
P. O. Box 12233
Research Triangle Park, North Carolina 27709

Edward P. Radford, M.D.
Professor of Environmental Medicine
School of Hygiene and Public Health
The Johns Hopkins University
615 North Wolfe Street
Baltimore, Maryland 21205

Benjamin F. Wake
Administrator, Environmental Sciences Division
Montana State Department of Health and
Environmental Sciences
Cogswell Building
Helena, Montana 59601

Grant S. Winn, Ph.D.
Chief, Air Quality Section
Utah State Division of Health
44 Medical Drive
Salt Lake City, Utah 84113

CRITERIA DOCUMENT: RECOMMENDATIONS FOR AN
OCCUPATIONAL EXPOSURE STANDARD FOR INORGANIC ARSENIC

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I. RECOMMENDATIONS FOR AN INORGANIC ARSENIC STANDARD

The National Institute for Occupational Safety and Health (NIOSH) recommends that worker exposure to arsenic and its inorganic compounds be controlled by requiring compliance with the following sections. The standard is designed to protect the health and safety of workers for a 40-hour week over a working lifetime. Compliance with all sections of the standard will prevent noncarcinogenic adverse effects of exposure to inorganic arsenic in the workplace air and by skin exposure, and should at the minimum materially reduce the risk of arsenic-induced cancer. The standard will be subject to review and will be revised as necessary.

"Arsenic" is defined as elemental arsenic and all of its inorganic compounds. "Exposure to arsenic" is defined as exposure at or above 0.002 mg (2.0 μ g) As/cu m. Arsine and other arsenical gases should be controlled to the same concentration as other forms of inorganic arsenic. Suitable sampling and analytical methods for arsenical gases are not yet available but are being developed.

Section 1 - Environmental (Workplace air)

(a) Concentration

Inorganic arsenic shall be controlled so that no worker is exposed to a concentration of arsenic in excess of 0.002 mg (2.0 μ g) per cubic meter of air as determined by a 15-minute sampling period.

(b) Sampling and Analysis

Procedures for sampling, calibration of equipment, and analysis of arsenic samples shall be as provided in Appendices I and II, or by any method shown to be equivalent in precision, accuracy, and sensitivity to the methods specified.

Section 2 - Medical

Medical surveillance shall be made available and related records kept as specified below for all workers occupationally exposed to arsenic.

(a) Preplacement and annual medical examinations shall include:

(1) Comprehensive preplacement or annual interim work history.

(2) Comprehensive preplacement or annual interim medical history.

(3) 14" x 17" posterior-anterior chest X-ray, giving particular attention to parenchymal and hilar changes.

(4) Careful examination of the skin to detect the presence of arsenic-induced hyperpigmentation, keratoses, or other chronic skin lesions. Skin examinations shall be repeated bimonthly if arsenic-induced skin lesions are detected. Care shall be taken to observe and record the location, condition, appearance, size, and any changes in all such lesions.

(5) Palpation of superficial lymph nodes to detect indications of neoplastic changes.

(6) Complete blood count to include differential.

(7) An evaluation of the advisability of the worker's using

negative- or positive-pressure respirators.

(b) A periodic sputum cytology examination is recommended for all workers occupationally exposed to inorganic arsenic. The frequency of this procedure should be determined by the responsible medical authority.

(c) Proper medical management shall be provided for workers adversely affected by occupational exposure to inorganic arsenic compounds.

(d) Initial annual examinations for presently employed workers shall be offered within 6 months of the promulgation of a standard incorporating these recommendations.

(e) The medical representatives of the Secretary of Health, Education, and Welfare, of the Secretary of Labor, and of the employer shall have access to all pertinent occupational medical records. Physicians designated and authorized by any employee or former employee shall have access to that worker's medical records.

(f) Medical records shall be maintained by the employer or successors thereto for persons employed one or more years in work involving exposure to arsenic. Preplacement X-rays, X-rays for the 5 years preceding termination of employment, and all other medical records with pertinent supporting documents shall be maintained at least 30 years after the individual's employment is terminated. In the event that the employer ceases business without a successor, records shall be forwarded by registered mail to the Director, National Institute for Occupational Safety and Health.

Section 3 - Labeling (Posting)

(a) Containers of arsenic compounds shall bear the following label in addition to or in combination with labels required by other statutes, regulations, or ordinances.

NAME OF COMPOUND
DANGER! CONTAINS ARSENIC
CANCER CAUSING AGENT
HARMFUL IF INHALED OR SWALLOWED, OR UPON SKIN CONTACT
AVOID CONTACT WITH SKIN, EYES, AND CLOTHING
WASH THOROUGHLY AFTER HANDLING

Avoid breathing dust or spray mist
Keep container closed
Use only with adequate ventilation

(b) The following warning sign shall be affixed in a readily visible location at or near entrances to areas in which there is occupational exposure to arsenic.

ARSENIC
DANGER! CANCER CAUSING AGENT

Dust or spray mist may be hazardous to health.
Provide adequate ventilation.

This sign shall be printed both in English and in the predominant language of non-English-speaking workers unless they are otherwise trained and informed of the hazardous area. All illiterate workers shall receive such training.

Section 4 - Personal Protective Equipment and Work Clothing

(a) Protective Clothing

(1) Where there is occupational exposure to inorganic arsenic compounds, protective clothing shall be provided by the employer. This may include underwear, gloves, coveralls, and a hood over the head and neck. When liquids are being processed in a manner that may result in splashes, impervious gloves, aprons, and splash goggles shall be used.

(2) Protective clothing shall be changed at least daily at the end of the shift.

(3) Work clothing shall not be taken home by employees. The employer shall provide for maintenance and laundering of protective clothing.

(4) The employer shall ensure that precautions necessary to protect laundry personnel are observed when soiled protective clothing is laundered.

(b) Respiratory Protection

(1) Engineering controls shall be used wherever feasible to maintain arsenic concentrations below the prescribed limit. Compliance with the permissible exposure limit may not be achieved by the use of respirators except:

(A) During the time period necessary to install or test the required engineering controls.

(B) For nonroutine operations such as a brief exposure to concentrations in excess of the permissible exposure limit as a result of maintenance or repair activities.

(C) During emergencies when air concentrations of arsenic may exceed the permissible limit.

(2) When a respirator is permitted by paragraph (b)(1) of this Section, it shall be selected and used pursuant to the following requirements:

(A) The employer shall ensure that no worker is being exposed to arsenic in excess of the environmental limit because of improper respirator selection, fit, use, or maintenance.

(B) A respiratory protection program meeting the requirements of 29 CFR 1910.134 as amended shall be established and enforced by the employer.

(C) The employer shall provide respirators in accordance with Table I-1 below and shall ensure that the employee uses the respirator provided.

(D) Respiratory protective devices described in Table I-1 shall be those approved under the provisions of 30 CFR 11 as amended.

(E) The employer shall ensure that respirators are adequately cleaned, and that employees are instructed in the use of respirators assigned to them, and how to test for leakage.

(F) Where an emergency may develop which could result in employee exposure to arsenic, the employer shall provide respiratory protection as listed in Table I-1.

TABLE I-1

- 1) Combination supplied air respirator, pressure demand type, with auxiliary self-contained air supply.
- 2) Self-contained breathing apparatus with positive pressure in the facepiece

Section 5 - Informing Employees of Hazards from Inorganic Arsenic

At the beginning of employment in an arsenic area, employees exposed to arsenic compounds shall be informed of the hazards, relevant symptoms of overexposure, appropriate emergency procedures, and proper conditions and precautions for safe use. Instruction shall include, as a minimum, all information in Appendix III which is applicable to the specific arsenic-containing product or material to which there is exposure. The information shall be posted in the work area and kept on file and readily accessible to the worker at all places of employment where arsenic is involved in unit processes and operations.

A continuing educational program shall be instituted to ensure that all workers have current knowledge of job hazards, proper maintenance procedures and cleanup methods, and that they know how to correctly use respiratory protective equipment and protective clothing.

Information as required shall be recorded on the "Material Safety Data Sheet" shown in Appendix III or on a similar form approved by the Occupational Safety and Health Administration, US Department of Labor.

Section 6 - Work Practices

(a) Readily accessible standby rooms under positive air pressure and in which the concentration of arsenic in the air is less than 2.0 $\mu\text{g As}/\text{cu m}$ shall be provided where there is occupational exposure to inorganic arsenic.

(b) Arsenic shall be removed from work areas by vacuum cleaning or wet methods. Cleaning may be performed by washing down with a hose, provided that a fine spray of water has first been laid down. Sweeping or other methods which can stir the dust into the air shall not be used.

(c) Waste material shall be disposed of in a manner which will prevent exposure of humans and animals as well as air and water pollution.

(d) Arsenic trichloride shall be handled only in enclosed systems sufficient to prevent skin contact and to prevent worker exposure in excess of the environmental limit.

(e) Where there is possibility of arsenic trichloride contact with the skin, emergency showers shall be provided in readily accessible locations. Eye-wash facilities shall also be conveniently located.

(f) Procedures for emergencies, including fire fighting, shall be established to meet foreseeable events. Necessary emergency equipment, including appropriate respiratory protective devices, shall be kept in readily accessible locations. Only self-contained breathing apparatus with positive pressure in the facepiece shall be used for fire fighting. Appropriate respirators should also be available for use during evacuation.

(g) Exhaust ventilation and enclosure of processes shall be used wherever practicable to control workplace concentrations.

(h) Air from the exhaust ventilation system shall not be recirculated into work areas, and necessary measures shall be taken to ensure that discharge outdoors will not produce a health hazard to humans or animals.

(i) Due to potential skin irritation associated with respirator use and arsenic dust exposure, workmen shall be permitted to leave the work area every 2 hours to wash their face and obtain a clean respirator.

Section 7 - Sanitation Practices

(a) Employees exposed to arsenic shall be provided with separate lockers or other storage facilities for street clothes and for work clothes.

(b) Employees exposed to arsenic shall not wear work clothing away from the plant.

(c) Facilities for shower baths shall be provided for employees exposed to arsenic. Workers shall shower bathe before changing into street clothes. Shower baths shall be cleaned following use after each work shift.

(d) Employees exposed to arsenic shall wash their hands and exposed skin before eating or smoking during the work shift.

(e) No food shall be permitted in areas where arsenic is handled, processed, or stored.

(f) Employees shall not smoke in areas where arsenic is handled, processed, or stored.

Section 8 - Monitoring and Recordkeeping

Workroom areas shall not be considered to have arsenic exposure if environmental levels, as determined on the basis of a professional industrial hygiene survey, are less than 2.0 $\mu\text{g As/cu m}$. Records of these surveys, including the basis for concluding that air levels are less than 2.0 $\mu\text{g As/cu m}$, shall be maintained in accordance with Section 8 (e). In workrooms where inorganic arsenic compounds are handled or processed, surveys shall be repeated at least annually and when any process change indicates a need for reevaluation. Requirements set forth below apply to areas in which 1 or more 15-minute breathing zone samples have indicated exposure at or above 2.0 $\mu\text{g As/cu m}$.

Employers shall maintain records of environmental exposures to arsenic based upon the following sampling and recording schedules:

(a) In all monitoring, sufficient breathing zone samples shall be collected to characterize the potential exposure of workers at each operation or process.

(b) The first environmental sampling shall be completed within 6 months of the promulgation of a standard incorporating these recommendations.

(c) Environmental samples shall be taken within 30 days after first operation of a new process or process changes.

(d) Samples shall be collected at least every 2 months for those work areas in which there is occupational exposure to inorganic arsenic.

(e) Records of all sampling and of medical examinations shall be maintained by the employer or successors thereto for at least 30 years after the individual's employment is terminated. Records shall indicate

the type of personal protective devices, if any, in use at the time of sampling. Records shall be maintained so that exposure information is available for individual employees, and each employee shall be able to obtain information on his own exposure. In the event that the employer ceases business without a successor, records shall be forwarded by registered mail to the Director, National Institute for Occupational Safety and Health.

II. INTRODUCTION

This report presents the criteria and the recommended standard based thereon which were prepared to meet the need for preventing occupational diseases arising from exposure to arsenic and its inorganic compounds. The criteria document fulfills the responsibility of the Secretary of Health, Education, and Welfare, under Section 20(a)(3) of the Occupational Safety and Health Act of 1970 to "...develop criteria dealing with toxic materials and harmful physical agents and substances which will describe...exposure levels at which no employee will suffer impaired health or functional capacities or diminished life expectancy as a result of his work experience."

The National Institute for Occupational Safety and Health (NIOSH), after a review of data and consultation with others, formalized a system for the development of criteria upon which standards can be established to protect the health of workers from exposure to hazardous chemical and physical agents.

These criteria for a standard for arsenic and its inorganic compounds are in a continuing series of criteria developed by NIOSH. The proposed standard applies only to the processing, manufacture, and use of inorganic arsenical products as applicable under the Occupational Safety and Health Act of 1970. When the inorganic arsenic criteria document was first published in January 1974, arsine and lead arsenate were excluded from the provisions of the recommended standard. They are included in these revised recommendations. The inclusion of arsine and other gaseous arsenicals poses some difficulties in that specific work practices are needed, and

sampling methods need investigation. However, these difficulties should not be cited as cause for permitting continued exposure to arsine at concentrations above 0.002 mg (2.0 μ g) As/cu m. NIOSH is working on these areas and will transmit recommendations directly to the Occupational Safety and Health Administration as soon as possible.

The standard was not designed for the population-at-large, and any extrapolation beyond general occupational exposures is not warranted. It is intended to (1) protect against the noncarcinogenic effects of inorganic arsenicals, (2) materially reduce the risk of arsenic-induced cancer, (3) be measurable by techniques that are valid, reproducible, and available to industry and official agencies, and (4) be attainable with existing technology.